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MATHEMATICAL LITERACY ABILITY OF STUDENTS FROM A COGNITIVE STYLE PERSPECTIVE ON RATIONAL NUMBERS

Yuni Nurfitriani[1], Yusfita Yusuf[2]*, Ucu Koswara[3]

[1] SMP Negeri 1 Ganeas
[1,2,3]Pendidikan Matematika FKIP Universitas Sebelas April
e-mail: *yusfitayusuf87@gmail.com

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Abstract
This study aims to describe mathematical literacy skills reviewed from cognitive styles of students. This study is a descriptive study with a qualitative approach. The subjects of this study consist of 4 students in grade VII A SMP Negeri 1 Ganeas in the odd semester for the 2023/2024. The instruments used in this study were a mathematical literacy ability test, the Group Embedded Figure Test (GEFT) test to find out the type of student cognitive style, and interview guidelines. The results of this study show that students with a field independent cognitive style have better mathematical literacy abilities than field dependent ones. Field independent students met almost all levels of mathematical literacy indicators, while field dependent students only met 3 levels of mathematical literacy abilities. Judging from all levels of literacy indicators, students with a field independent cognitive style meet all levels of mathematical literacy. Meanwhile, students with a field independent cognitive style are only able to meet part of the level of mathematical literacy.

Keywords: Cognitive Style, Field Independent, Fields Dependent, Mathematical Literacy

1. Introduction

The Programme for International Student Assessment (PISA) is one of the benchmarks used by the Service of Instruction and Culture (Kemendikbud) to assess student learning. Children between the ages of 15 years 3 months and 16 years 2 months can have their achievement evaluated using the PISA program (Hertiandito, 2016; Puspendik, 2019; OECD, 2019; Hewi & Shaleh, 2020). PISA is a global assessment tool that can be used to gauge Indonesian students' proficiency in the global education system. Every three years, PISA conducts an assessment with an emphasis on a nation's educational system. Since the PISA assessment was originally conducted in 2000, the number of participating countries has increased; as of 2018, 41 to 79 countries were recorded as participants in the PISA assessment under the Organization for Economic Co-operation and Development (OECD, 2019). According to the latest PISA results, more than three out of four 15-year-old students in Indonesia were under the minimum proficiency levels in mathematics. This low level of mathematical literacy is indicative of deeper systemic issues within the educational framework, including inadequate teacher training, outdated curricula, and insufficient learning resources1. The *Merdeka Belajar* (Emancipated Learning) reform aims to address these challenges by focusing on foundational learning and empowering teachers1. However, the effectiveness of these reforms in improving mathematical literacy remains to be fully assessed (OECD, 2023). There are various literacy abilities that are the focus of PISA, such as reading literacy, mathematics literacy, and science literacy (Puspendik, 2019).

Mathematical literacy ability is the ability to think logically and critically when solving contextual problems, not just routine problems (Sari, 2015). Mathematical literacy ability is the capacity of students to define, apply, and translate arithmetic in different settings; the capacity to reason numerically and utilize self-concept. In general, it is the capacity to comprehend the basics of mathematics. (Lindawati, 2018). Concurring to PISA (Puspendik, 2019), it is an individual's capacity to define, utilize, and decipher mathematical concepts in a assortment of settings. Mathematical literacy incorporates mathematical rationale and the utilize of numerical concepts, methods, realities, and instruments to portray and anticipate a wonder.

Mathematical literacy could enhance student's ability to analyze logically and solve issues by evaluating the facts and following appropriate methods. This occurs as a result of the ability to apply mathematical literacy to help people comprehend how to apply mathematics to solve problems in their daily lives in an efficient and effective manner (Sari & Wijaya, 2017). Strong mathematical literacy abilities also make a person more perceptive to other pertinent mathematical ideas, which helps them identify the best way to solve difficulties (Asmara, Waluya, & Rochmad, 2017). In addition, the development of mathematical literacy in students will be highly beneficial in solving real-world issues that affect the caliber of human resources. This supports Masjaya & Wardono's (2018) assertion that literacy has a direct impact on the quality of human resources, such as having the ability to think more systematically, analytically, and critically when making the right decisions (Khasanah et al., 2023).

PISA categorizes mathematical literacy abilities into six categories, with various ability indicators at each level. Students' skill will improve as their level of mathematical literacy rises. Indonesian students still have low mathematical literacy levels (Anwar, 2018). This is due to the fact that mathematical literacy is only taught to children through their study of mathematics; it is not a subject in Indonesia (Lestari, 2019). According to the findings of five PISA assessments, students' mathematical literacy abilities are typically lower when compared to other PISA participating nations (Zahro and Haeruddin, 2022).

Low mathematical literacy also occurs at the place where researchers work, namely SMP Negeri 1 Ganeas. The results of observations carried out at SMP Negeri 1 Ganeas showed that many students experienced mathematical literacy problems such as weaknesses in formulating, using, interpreting, and lack of ability to change a context into mathematical form. This can be seen during the class. The students could not solve the problems given when it comes to story questions. Students have difficulty interpreting the questions and changing sentences into mathematical sentences. In addition, the results of the Computer-Based National Assessment (ANBK) of SMP Negeri 1 Ganeas from year to year show that the results of numeracy literacy are still low. This low level of mathematical literacy also occurs in other areas such as Bukit Tinggi (Rusdi, 2016) and in Yogyakarta (Sari & Wijaya, 2017).

Several factors play a role in diminishing mathematical literacy. According to Slameto (2010), there are two main factors that determine mathematical literacy: student ability and environmental conditions. Mahdiansyah and Rahmawati (2014) agreed with Slameto and claimed that the elements that influence students' mathematical literacy are internal (within the students) and external (outside the students). Meanwhile, Ananda and Wandini (2022) said that the low level of mathematics literacy among Indonesian students is related to personal, instructional, and environmental variables. According to Pakpahan (2016), the factors influencing the mathematical literacy of Indonesian students in the 2012 PISA study are the participants' backgrounds, which include both internal factors such as student identity and external factors such as family situations, ownership of learning resources, and social and cultural environments at home.

One of the individual components that impacts mathematical literacy capacity is cognitive style. Each student contains a special strategy of understanding a mathematical problem (Santoso & Setyaningsih, 2020). This is consistent with the opinion of Vendiagrys and Junaedi (Wulan and Anggraini, 2019) claiming that cognitive style contributes as one of the influencing factors plays a significant part in the problem-solving process. When students solve a mathematical problem, they utilize representations to improve the problem in their mental representations. This process is related to cognitive styleA person's cognitive style is most likely an innate and natural response to information and events (Riding and Rayner, 2012). Cognitive style refers to a person's usual learning style, which encompasses how they collect and process information, attitudes toward the information that they obtain, and behaviors toward the learning environment (Keefe in Alghofiqi, 2020). There is evidence that people have habitual approaches to activities and situations that correspond to patterns in cognitive processes such as decision making, problem solving, perception, and attention. (Bendal, et al., 2016). Students' cognitive style is one of the individual components (Mahdiansyah & Rahmawati, 2014).

When a learner encounters a challenge, their cognitive style determines how they will process information differently. Experts have created a variety of cognitive style factors that allow for individual differentiation (Yusuf & Sukestiyarno, 2022). The findings of study by Witkin, Oltman, Raskin, and Karp (Ghufron & Suminta, 2010) have led to the development of two popular types of cognitive styles: field dependent (FD) and field independent (FI). A commonly researched aspect of cognitive styles is called field dependence–independence (FDI), which assesses a person's capacity to recognize embedded elements of a structured visual field as distinct entities from that particular field (Pharmaki, et al., 2019). Students with a FI cognitive style, according to Amalia, Wildani, and Rifa'i (2020), have the ability to explain things, are self-motivated, and prefer to work alone, whereas students with a FD cognitive style require more clues to solve a problem, like to work in groups or learn together and require inspiration or support from others or outward. Moreover, Febriana et al. (2022) reported that people with a FD cognitive style are less able to perform tasks than people with a FI cognitive style, who are better at processing information, including hiding and sorting it to fit the situation. Several studies claim that students with various cognitive styles approach problem-solving and information processing in distinct ways (Hassan, 2002). According to Yusuf et al. (2020), before instruction starts, we must ascertain the pupils' conditions. This viewpoint is consistent with Susanto's (2008) statement that educators need to consider students' cognitive styles while implementing teaching strategies, which includes conceptual comprehension. This is so that the learning that has been designed can support this. One of the things to keep in mind when gaining mathematical literacy is cognitive style. This is similar to the findings of a study by Rum & Juandi (2023) that used the Systematic Literature Review research method and found that high school students' processes of becoming mathematically literate differ for students with the FD cognitive style and FI students. Thus, the goal of this study is to comprehend students' mathematical literacy skills in light of their cognitive styles.

2. Methods

Qualitative descriptive research, which aims to describe a natural event that has occurred, already exists, or is now taking place, was the research type employed in this study (Sukestiyarno, 2020). Researchers use the qualitative technique to explain how students solve difficulties and identify issues when working on mathematical literacy problems according to their cognitive type capacities. Pupils in grade VII at SMP Negeri 1 Ganeas, situated on Jln. Dayeuhluhur Km.1 Ganeas in Sukawening, Ganeas District, Sumedang Regency, West Java, participated in the study. 32 pupils in class VII A, where the researcher is the instructor, served as the study's subjects. In 2023–2024, this research will be conducted during the academic year.

The methods for gathering information are divided into three phases. The participants first took the Group Embedded Figures Test (GEFT) to determine their cognitive styles. They then addressed PISA-based concerns about mathematical literacy. Ultimately, two students who preferred the FI learning method and two students who preferred the FD learning style were selected.

The GEFT cognitive style assessment, an essay-based PISA-based mathematical literacy test with six questions for each PISA level, and a structured interview are the study tools utilized. There are twenty-five picture questions on the GEFT test; seven are practice questions and the remaining eighteen are real tests. If the student scores > 9, it is classified as an independent field, while the student scores ≤ 9, it is classified as a dependent field (Dibyantoro, 2013). Then in the math literacy test, the score obtained will be converted into a score scale of 1-100 which will be categorized based on the level of ability. Table 1 shows the leveling used for mathematical literacy.

Table 1

The Levels of Mathematical Literacy

Level	Student Ability Indicator
Level 1	Answer questions with a familiar context, gather relevant information, and take an action that is appropriate to the stimulus
Level 2	Recognize situations, use algorithms or formulas, and interpret them.
Level 3	Implement problem-solving strategies with good procedures, interpret, and represent situations.
Level 4	Work with models effectively in concrete but complex situations, represent different pieces of information and relate them to the real world
Level 5	Work on complex situations with models to solve complex problems and select and implement a strategy.
Level 6	Using reasoning, making generalizations, and communicating a solution to the problem.

Source: OECD (2019)

Triangulation, in expansion to the written test, the four members were interviewed. Students were interviewed after completing mathematical literacy questions. What was inquired during the interview was around mathematical literacy questions that had been worked on. The questioner inquires whether the student can do it and how to do it. On the off chance that students encounter troubles in their work, the interviewer inquires what the problem is and inquires stimulating questions related to the concepts utilized in understanding it. Information investigation was carried out employing a constant comparative strategy. Typically, because information investigation continuously compares one datum to another, it eventually compares one category to another (Moleong, 2009). In general, the investigation preparation includes information reduction, categorization, synthesis, and conclusion with working hypothesis.

3. Result and Discussion

This study aims to understand mathematical literacy from the perspective of cognitive style. The results of the GEFT assessment on grade VII A students of SMP Negeri 1 Ganeas can be seen in table 2.

Table 2

The Results of Cognitive Style Test

Cognitive Style	The Number of Students
Field Independent	10
Field Dependent	22

Furthermore, based on the mathematical literacy test that has been carried out, purposive sampling selected 4 research subjects consisting of 2 field independent students and 2 field dependent students. The subjects were chosen based on the two highest scores in the mathematical literacy test from each cognitive style category. The subject was chosen with the intention of conducting additional interviews to obtain answers to the mathematics literacy test. Table 3 shows a list of research subjects.

Table 3

The List of Research Subjects

Sudent Code	Cognitive Style	Subject Code	Score
S02	FI	S-FI_1	100
S26	FI	S-FI_2	88
S15	FD	S-FD_1	65
S16	FD	S-FD_2	50

Based on table 3, the FI cognitive style students outperformed the FD cognitive style students on the mathematical literacy test. Compared to FD individuals, FI subjects do better on problem-solving profiles. Furthermore, students with the FI cognitive style type have a higher level of mathematical creative thinking skills and are better at problem-solving than students with the FD cognitive style, according to research by Amini, Nufus, and Agustin (2023), and research by Wulan and Angriani (2019). According to Shiddieqy, Sudiana, and Pamungkas's research findings from 2023, pupils who have strong mathematical connection abilities typically have a FI cognitive style type. Students with the FI cognitive style have better mathematical abilities compared to students with the FD cognitive style. This happens because students with the FI cognitive style remember more easily and have strong memories (Suhaji, Widadah, Sukriyah, 2020; Ginting and Nasution, 2024).

Figures 1 and 2 show the results of further analysis of the students' mathematical literacy test answers.

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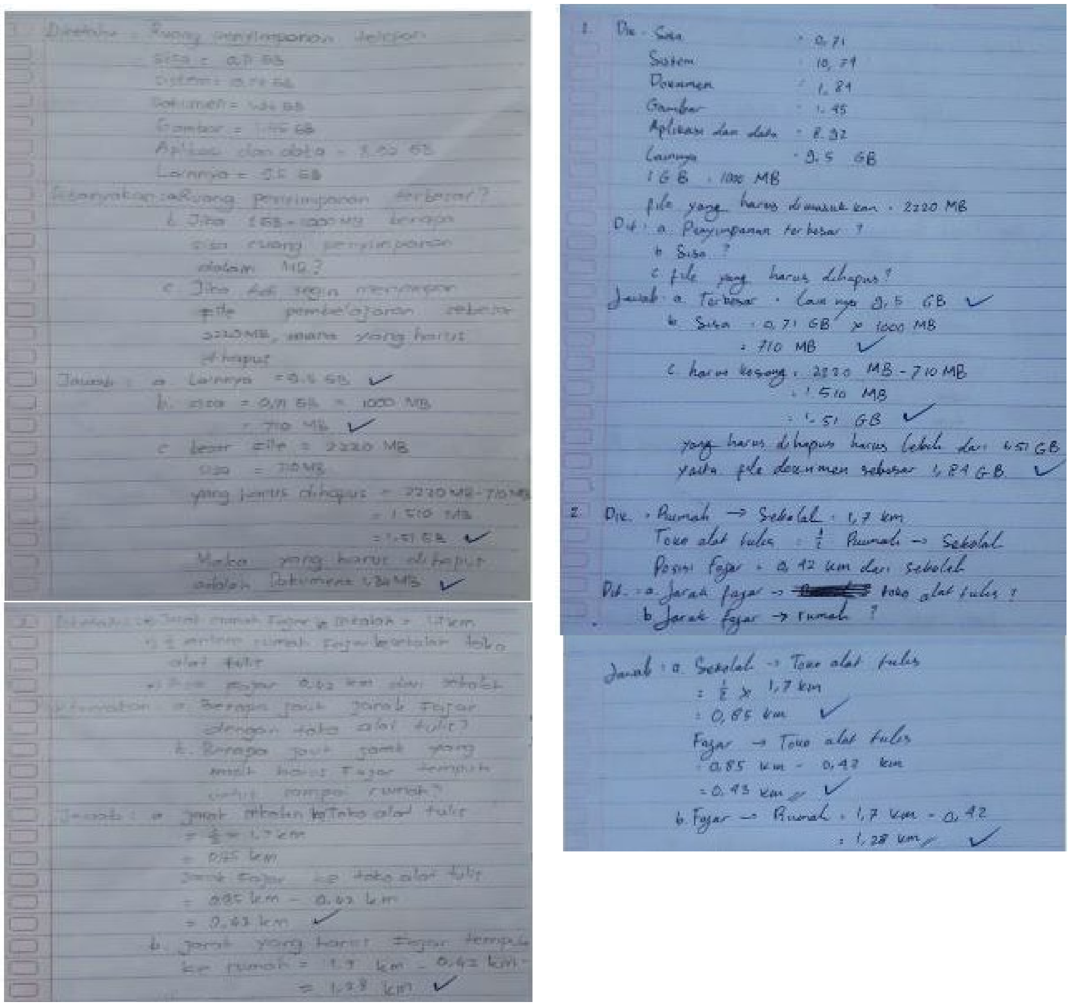

a b

Figure 1
The Results of S-FI$_1$ Statistical Literacy Test (a) and S-FI$_2$ Statistical Literacy Test (b)

Based on figure 1, it can be seen that both subjects have met mathematical literacy levels 1 to 6. However, S-FI1 writes down the information contained from the questions in detail, unlike S-FI2 which only writes down the important points. However, both have met level 1, i.e. gathering relevant information, and taking an action that is appropriate to the stimulus. This aligns with the statements of Wulan and Anggraini (2019); Pramudya, Wirevenska, and Sitepu (2020); Ginting and Nasution, (2024) who stated that FI subjects are able to observe problems and identify information in the questions, such as mentioning what is known and what is asked of the questions. Furthermore, Wulan and Anggraini (2019) stated that FI subjects who are more skilled in rearranging information. The subject S-FI2 has characteristics as stated by Yusuf and Sukestiyarno (2022) that the subject of FI at this stage only records important elements. This is in accordance with the characteristics of FI subjects, namely they internally exhibit and process information with their own structures (Witkin, Moore, Goodenough, & Cox, 1977).

From the different problems in number 1 and number 2, the two subjects can recognize the situation, use algorithms or formulas, and interpret the problems presented correctly. This is in line with the characteristics possessed by the FI subjects who tend to be able to analyze a situation, problem and be able to rearrange the information and they have the motivation in themselves to solve the problem well (Amini, Nufus, and Agustin, 2023). Moreover, both FI subjects are also able to apply problem-solving strategies with good procedures, interpret, and represent situations. This can be clearly seen from Figure 1 where both FI subjects can apply the solving strategy well. This condition shows that FI subjects can prepare a more mature plan (Wulan and Anggraini, 2019). Especially in Figure 1.b, where the S-FI2 subject expresses the distance using arrows. This is one of the ways that the subject uses to interpret and represent the situation. In addition, the use of arrows also indicates that the FI Subject works effectively with the model in concrete but complex situations, representing different pieces of information and relating them to the real world. This trait is consistent with the finding made by Mamonto et al. (2018) that FI students can effectively duplicate the model.

Both subjects with FI cognitive style were able to work on complex situations with models to solve complex problems and choose and apply a strategy. This happens because subjects with FI cognitive style are capable of identifying the necessary concepts to solve the provided problems (Yusuf and Sukestiyarno, 2022). Moreover, subjects with FI cognitive style understand the relationship between mathematical concepts and other fields. This is in accordance with Setyaningsih, Asikin & Mariani (2016) research which states that FI students are able to find a solution concept, understand between mathematical topics, and are able to apply mathematics in other fields and in daily life. Furthermore, Ginting and Nasution (2024) stated that the characteristics of FI students tend to be more analytic in formulating problems, which means that problems are made into small parts and then find relationships between existing parts. However, the subject of S-FI2 has not made generalizations and communicated the solution of the problem appropriately. During the interview, the S-FI2 subject was able to explain the stages of working on the problem and make appropriate generalizations. The subject of S-FI2 does tend to write only important things and some things are written in the form of symbols. This aligns with Yusuf and Sukestiyarno (2022) research that stated students with FI cognitive style can interpret the results well.

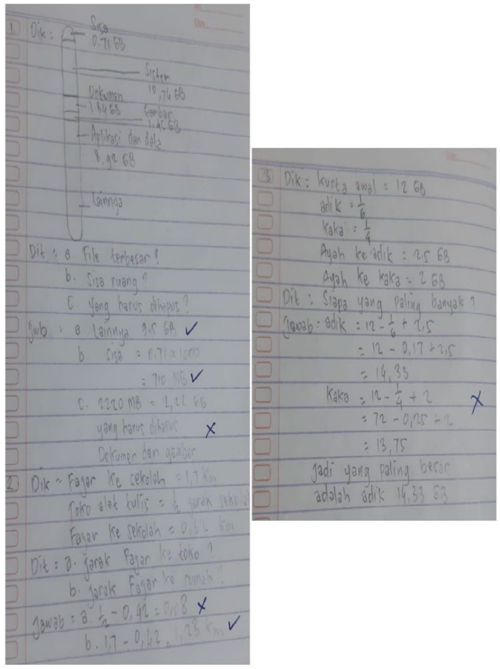

Figure 2.a. The Results of S-FD_1 Statistical Literacy Test

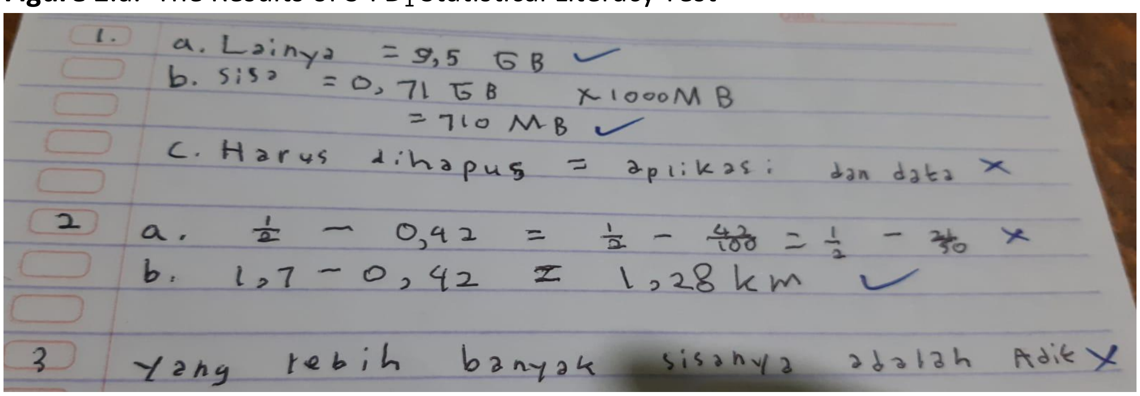

Figure 2.b. The Results of S-FD_2 Statistical Literacy Test

Figure 2 show that the subject of S-FD1 identifies the problem by presenting it in the form of an image. In contrast to the subject of S-FD2 which does not write any information about the problems given. During the interview, it turned out that the subject S-FD2 wrote information on a different paper because the subject thought that filtering information related to the problem was not part of solving the problem. This aligns with findings from Wulan's research and Anggraini (2019) that FD subjects in the process of understanding problems can be categorized as lacking. Subjects with FD style also do not write down the solution steps used in solving the problems given. When the

FD subjects asked why they used the solution, subjects with FD cognitive style could not explain the selection of procedures carried out, instead they admitted that they wanted to ask the teacher how to solve the given problems. This condition is in line with the characteristics of FD subjects that FD subjects like to seek guidance from the teachers (Yasa., et al., 2013). As a result, at other literacy levels, subjects with FD cognitive style could not meet other levels of mathematical literacy

4. Conclusion

Based on the results and discussion and upheld by the results of interviews with the subjects, it can be concluded that: students with a field independent cognitive style have way better mathematical literacy abilities than students who have a field dependent cognitive style. Judging from all levels of literacy pointers, students with a field independent cognitive style meet all levels of mathematical literacy. In the mean time, students with a field independent cognitive style are as it were able to meet portion of the level of mathematical literacy.

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